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The Photon Has a Central Core in Which Resides a Positive Electrical Charge and It Is Composed of Quarks, Antiquarks and Gluons Degraded and It Obeys the Laws of the Capacitors

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Abstract

In this work, I propose two new equations which provide very useful information on how they are structured photons. These equations tells us that the photon behaves like a true capacitor and it informs us as well that the energy of a photon is a function of its voltage, its electric field, its magnetic field, the module Poynting, photon volume, the frequency and its wavelength. In this equation, it also presents the electrical charge unitary, the radius of photon and the radius of its core.

These equations are also a function of the mass density of the photon, of its mass and of 7 physical constants.

The energy thus calculated corresponds to the equation $e = mc^2$ and this clearly indicates that the equations proposed are able to provide all the information about the photon which until now has been ignored.

A photon can behave like a capacitor if it has a core which acts as a positively charged electrode. This capacitor, which may be called "photonic capacitor", also has a negative electrical charge that rotates at the speed of light on the shell of the photon.

Both the core of photon that the space between it and the shell are constituted by quarks, antiquarks an gluons degraded.

About one microsecond after the Big Bang, when the universe has created ordinary matter, the core of the photons, that were present then, consisting of two up quarks and a down quark and gluons. The image that provides the capacitor photonic allows us to fully understand structure of a photon.

The photon behaves simultaneously by wave and particle.

Keywords

Photonics; Microsystems; Black Body; Laser; Physics; Accelerated Particles; Nanotechnologies; Light; White Body; Cosmology

Introduction

The equation used to calculate the energy of a photon is the famous $E = h\nu$. This equation was presented, for the first time, by the German physicist Max Planck at the Academy of Berlin on December of the year 1900. This equation has an analytical form very simple and indicates that each photon has an energy proportional to its frequency. However, it does not give us other information on the physical nature of this particle which it is of fundamental importance for the physical and for all sciences.

The equations that I propose in this paper are equations which are a function of the frequency of a photon and allows us to discover its structure.

These equations demonstrate, among other things, that each photon simultaneously exhibits the behavior of wave and particle.

This means, no doubt, that a photon that behaves in this way does not obey principle of complementarity Bohr. This principle states, in fact, that the two aspects of the photon, the wave and the particle, should manifest itself in

different contexts.

A series of experiments recently carried out [6-14] has shown that the dual nature of light is manifested simultaneously. During the National Conference of Associazione Italiana Sensori e Microsistemi (AISEM), I stated that the wave and the particle of a photon occur this their dual nature simultaneously.

This Conference was held in Rome in February 2011 and was carried out in collaboration with ENEA. I reaffirmed my idea in the book published by Springer in January 2012 by AISEM and ENEA.

The equation that I present in this work provides convincing evidence the simultaneous dual nature of the light and presents some new properties that revolutionize our present knowledge.

The photons, in fact, as I have shown in my work *" The Photons, Contrary to What Is Believed, Have a Mass and Density and They Obey the Law of Stefan-Boltzmann"* published in June 2015 on "Frontiers in Sensors" are particles that have a density directly proportional to their frequency.

Deepening my research, I discovered that each photon has a central core with a density greater than that of photon of about six thousand times.

In each photonic core, a positive elementary electrical charge is placed.

The electrical charge is balanced by a negative electrical charge which rotates, to the speed of light, on the surface of the photon. This charge, by rotating on the surface, produces a circumference with a radius which measures how the wavelength of the photon.

I verified, moreover, that each photon behaves as a capacitor spherical and obeys its laws.

The central core of each photon produces an electric field that remains confined within the photon. The negative electric charge which rotates on the surface of the photon, produces, however, a magnetic field that is directed toward the core. A photon, with this structure, stores energy. This energy can be calculated with the laws of the capacitors.

Comparison between a Capacitor and a Capacitor Photonic

We observe now that each capacitor consists of two electrodes subjected to a potential difference. These two electrodes can be separated from the vacuum or by a dielectric.

In a condenser photonic, between the core and the surface of photon, there is the matter. This matter is made up of quarks, antiquarks and gluons degraded and it is accompanied by energy according to $E = mc^2$. Also the core of the photon consists of matter and energy that were formed by the degradation of quarks, antiquarks and gluons. The matter and the energy of the core constitute the 3% of all the matter and energy of the photon. If each photon was devoid of electric charge, we would not be able to explain the electromagnetic nature of it and we would not even be able to explain how a photon, which is broken down into two parts, is able to produce an electron and positron, or a proton and an antiproton.

As Were the Photons When It Formed the Ordinary Matter?

My universe model, published in 2008, in my book [1] called "Un Microscopico Buco Nero all'Origine dell'Universo" informs us that at the time of a microsecond the universe was formed by photons. They possessed in their core two up quarks (+2/3) and a down quark (-1/2) bound together by gluons. The space between the core and the outer shell was completely full of quarks and antiquarks and gluons. These particles were formed and annihilated instantly. The photons of that time revolved on themselves at the speed of light and were juxtaposed to each other. The space was formed from these particles.

Some researches have led to the discovery that the universe, at the time of a microsecond when its temperature was about 1000 billion degrees, consisted of a sea of quarks, antiquarks and gluons. This research provides value to my model.

Between the photons of that time and ordinary matter, it was then a very close relationship.

The Equations Proposed

The equations proposed in this paper calculate the energy of a photon in function of its mass density, the module Poynting, the electric charge unit and the potential of a capacitor photonic and provide the same results as E = hν.

The Poynting vector is a part of the electromagnetic theory of Maxwell. Robert P. Crease e Alfred Scharff Goldhaber [3] referred to pag. 151 of their book entitled "Ogni cosa è indeterminata", che *"la teoria di Maxwell dell'elettromagnetismo definisce l'intensità della potenza associata a un'onda elettromagnetica classica attraverso il cosiddetto vettore di Poynting, un'espressione in cui entrano sia l'intensità del campo elettrico sia quella del campo magnetico dell'onda."*

The Poynting vector is spread along the direction of motion of the wave and is a very important element of the theory of Maxwell.

Its presence in the equation proposal shows that there is a link between the properties of a particle and those of a wave.

The form of Poynting is a function of the electric field and the magnetic field.

With the following equation:

$$E = 8{,}155 \cdot 10^{-25} \cdot \nu^2$$

that I produced, as shown in the appendix (1), you can calculate the electric field of a photon as a function of its frequency.

The electric field of the photon can also be calculated through the following equation that applies to the spherical capacitor.

$$E = \left[\left(\frac{Q}{4\pi \cdot \varepsilon_0}\right) \cdot \left(\frac{\lambda - 0{,}01928 \cdot \lambda}{0{,}01928 \cdot \lambda^2}\right)\right] \cdot \lambda^{-1} = \text{voltaggio} \cdot \lambda^{-1}$$

This equation shows, unquestionably, that the electric field of a photon is a function of the elementary charge Q and of the geometric dimensions of the core photonic (0,01928 λ) and the outer shell λ.

Analytical Form of the Equations Proposed:

$$e = h \cdot \nu = \left\{\left[k_A \cdot \left(\frac{E \cdot B}{\mu_0}\right) \cdot \nu^8\right]^{1/3} \cdot V_{phot}\right\} \cdot c^2 = m \cdot c^2$$

$$e = h \cdot \nu = \left\{\left[1{,}584 \cdot 10^{-178} \cdot \left(\frac{Q}{4\pi \cdot \varepsilon_0} \cdot \frac{\lambda - 0{,}01928 \cdot \lambda}{0{,}01928 \cdot \lambda^3}\right)^2 \cdot \frac{\nu^8}{c \cdot \mu_0}\right]^{1/3} \cdot \frac{4}{3}\pi \cdot \lambda^3\right\} \cdot c^2 = m \cdot c^2$$

were:

k_A = 1,584 x 10^{-178} (s^{-11}x m^{-3}) = [(0,5625 $h^{5/3}$ $\varepsilon_0^{1/2}$ $l_P^{2/3}$ $\mu_0^{1/2}$)/(c^{11} $G^{1/3}$ π^2)]
(E B/μ_0) = module Poynting (J/(s x m^2) or (W/m^2)
μ_0 = magnetic constant = 12,566 x 10^{-7} (N A^{-2})
E = electric field (N/C) = [Q/(4 π ε_0)] x [(λ – 0,01928 λ)/(0,01928 λ^3)] = 8,155 x 10^{-25} ν^2
B = E/c = magnetic field (Tesla)
Q = elementary charge = 1,602 x 10^{-19} Coulomb
ε_0 = electric constant = 8,854 x 10^{-12} (F m^{-1})
λ = wavelength of the photon = ray of photon
ν = frequency of the photon (s^{-1}) or (hertz)
V_{phot} = volume of the photon = (4/3) π λ^3 (m^3)
c = speed of light = 2,99792 x 10^8 (m/s)
m = mass of the photon (kg)
[k_A x (E B/μ_0) ν^8] = bulk density (kg/m^3)
{[k_A x (E B/μ_0) ν^8] x $V_{phot.}$ } = mass of the photon (kg)
h = Planck constant = 6,626 x 10^{-34} Joule x s

l_P = Planck length = 4,050 x 10^{-35} m
G = Newtonian constant of gravitation = 6,673 x 10^{11} (m^3 kg^{-1} s^{-2})

Negative Electric Charge

An electron is a binary system formed by a mass of 9,109 x 10^{-28} g and by an elementary electric charge of negative sign of 1,602 x 10^{-19} coulomb. A photon has a positive electrical charge placed in its core. The core of photon has a mass which corresponds to a thirty-fist part of that of the entire photon. The negative electrical charge of the photon is placed on its surface.

If an electric charge moves on a circular orbit, placed on a plane perpendicular to that on which is placed the magnetic field, it must verify the equation [4]:

$$R = \frac{m \cdot c}{Q \cdot B}$$

R = photon radius (m)
m = mass which support negative electrical charge (kg)
Q = elementary electrical charge = 1,602 x 10^{-19} Coulomb
B = magnetic field (T)
c = speed of light = 2,99792 x 10^8 m/s

The presence in this equation of a mass has a very deep meaning. It means that a naked charge cannot exist. Each electric charge, in order to exist and to be able to move in a magnetic field, it must bind to a mass. We do not know the size of the mass that supports this negative charge and do not even know the speed of rotation of this charge.

However, we know that the spherical surface on which it moves this charge has a radius which measures how the wavelength of the photon.

If we assume that this charge is moving at the speed of light, we can use the equation above written to calculate the value of the mass that must carry this load.

In case it turns out the mass, which must carry the negative charge, is larger than that of the photon itself, we would be forced to admit that my conclusions are wrong.

I have verified that this mass is always 15,5 times lower than that of the photon in which it is located.

A photon with a radius of 1,320 x 10^{-15} m is immersed in a magnetic field of 1,530 x 10^{14} tesla. If the negative charge that this photon possesses rotates at the speed of light, it happens that the mass on which it is situated measure 1,080 x 10^{-28} kg.

$$e = energia\ carica\ rotante = \left({}^{h}/_{16,920}\right) \cdot v \qquad \text{(appendix 5)}$$

The Universe When It Was Formed Ordinary Matter

The Universe, when it was produced ordinary matter, protons, neutrons and electrons, possessed, according to the cosmology, an age of about one microsecond.

The equation of the author:

$$\text{Age of the Universe (s)} = 10^{\left\{\left|\log\left(\frac{\text{photon mass}}{10^{-26,509467}}\right)\right|/-0,518964\right\}};$$

This equation allows you to calculate the time when the Universe was populated by photons with a given mass. When the universe was populated by photons with a mass of 1,67454 x 10^{-24} g, corresponding to that of the neutrons, it formed the ordinary matter. This occurred, according to the above equation and how the cosmologists say, when the universe was an age of 5,40 microseconds.

If, for example, this equation fits the mass of Planck of 5,46 x 10^{-5} g, you will obtain a time of about 10^{-43} seconds which corresponds perfectly to that of Planck and this shows that the equation written above provides consistent results.

According to my model, the universe, at the time of 5,40 microseconds, was populated by particles with the following characteristics:

$m = 1{,}67454 \times 10^{-24}$ g
$T = 2{,}189 \times 10^{12}$ K
$\nu = 2{,}2715 \times 10^{23}$ hertz
$\lambda = 1{,}320 \times 10^{-13}$ cm
energy = $1{,}505 \times 10^{-3}$ erg = 939 MeV
average density = $1{,}739 \times 10^{14}$ g/cm^3

Hans Gutbrod e Horst Stocker, in their article [5] titled "L'equazione di stato del nucleo" published in Januery 1992 in the journal Le Scienze (Italian edition of Scientific American) said:*"La temperatura dell'universo è andata diminuendo a partire dal big bang. Si pensa che durante il primo microsecondo tutta la materia si trovasse nella fase di plasma di quark e gluoni. Mentre l'universo si espandeva e raffreddava, tipi più complessi di materia condensavano dal plasma, fino a formare gli atomi."*

These particles were photons that revolved on themselves at the speed of light and possessed a wavelength of 132 x 10^{-17} m. They possessed the characteristics of capacitors and obeyed their laws. Each of these photons, if he obeyed the laws of the capacitor, he would have to possess a voltage of 55,484 million volts.

$$V = V_a - V_b = \left(\frac{Q}{4\pi \cdot \varepsilon_0}\right) \cdot \left(\frac{b-a}{a \cdot b}\right) =$$

$$= \left(\frac{Q}{4\pi \cdot \varepsilon_0}\right) \cdot \frac{(132 \cdot 10^{-17}) - (2{,}544 \cdot 10^{-17})}{(132 \cdot 10^{-17}) \cdot (2{,}544 \cdot 10^{-17})} =$$

$$= \frac{1{,}602 \cdot 10^{-19}}{4 \cdot 3{,}14 \cdot 8{,}85 \cdot 10^{-12}} \cdot \frac{(132 \cdot 10^{-17}) - (2{,}544 \cdot 10^{-17})}{(132 \cdot 10^{-17}) \cdot (2{,}544 \cdot 10^{-17})} =$$

$$= 55{,}484 \cdot 10^6 \text{ volts};$$

$$b = 0{,}01928 \cdot \lambda = 0{,}01928 \cdot 132 \cdot 10^{-17}\text{m} = \text{radius of nucleus photon} = 2{,}544 \cdot 10^{-17}\text{m}$$

This is an extremely high voltage which seem cannot belong to a particle with a size of 132 x 10^{-17} m. However, this is the correct voltage because it allows to accumulate an amount of energy compatible with that possessed by a photon.

This capacitor photonic possessed two radius: one of 132 x 10^{-17} m, relative to its size, and one of 2,544 x 10^{-17} m relative to the size of its nucleus. It is very important to observe that the core of this photon was much denser than the rest of the photon.

My equations inform us that the density of the core was 7173 x 10^{14} g/cm^3 and it was 4000 time larger than the rest of photon. It measured 1,793 x 10^{14} g/cm^3.

This information, very important, has been obtained from me, because I have considered the photon as if it were a capacitor that is a system constituted by a center armature provided with positive electric charge and an outer armature with negative electric charge. If between the core and the outer shell there was a vacuum, this capacitor would have accumulated an energy of 27,740 MeV.

$$U = (0{,}5 \cdot Q \cdot V) = 0{,}5 \cdot 1{,}602 \cdot 10^{-19} \cdot 55{,}484 \cdot 10^6 = 4{,}444 \cdot 10^{-12} \text{ joule} = 27{,}740 \text{ MeV}$$

The photon, at the time of 5,40 microseconds, had an energy of 939,287 MeV. This energy is about 31 time greater of that which the photon would have if he behaved like a capacitor without dielectric.

The energy of the photon is:

$$e = h \cdot \nu = 6{,}626 \cdot 10^{-34} \cdot 2{,}2715 \cdot 10^{23} = 1{,}505 \cdot 10^{-10} \text{ joule} = 939{,}450 \text{ MeV}$$

Therefore, if the photon had not possessed material between its core and its shell, it would have to act as a condenser vacuum. In this case, its energy would have been that of 27,740 MeV.

In the capacitor macroscopic, the dielectric is a material that subtracts part of the energy that they succeed in accumulating. In the case of capacitors photonic, the opposite happens. The material, interposed between the outer shell and the core, brings energy to the condenser and in the case considered, it provides about 909,450 MeV of energy that are in addition to 27,740 MeV that the condenser vacuum is able to accumulate. We must now ask ourselves why the capacitor photonic, when it is free of material interposed between its core and its shell, is able to accumulate 27,740 MeV energy and we must try to understand where you place this energy.

The Masses of Quarks

So that a photon behaves as a capacitor, it should have a positive electric charge in the nucleus. This charge must be elementary.

In the case of photons that have been present in the universe one microsecond after the big bang, this charge was generated by two up quarks (+1/3) and a down quark (-2/3). Physics is not able to accurately measure and direct way the masses of these quarks because they are confined inside protons, neutrons ad mesons. Nevertheless, the researchers were able, through indirect measures, to derive their value with a good degree of accuracy. The researchers measured the masses of the quarks. The up quarks have a mass of about 0,9 x 10^{-26} g and the down quarks have a mass of about 1,8 x 10^{-26} g.

In core photonic, there are two up quark and one down quark and their total mass is about 3,6 x 10^{-26} g. This mass is accompanied, for the $E = mc^2$, with an energy of 20,244 MeV.

We saw that the photons present when the universe was at an age of 5,40 microseconds possessed a potential difference of 55,484 x 10^6 volts and they were able to accumulate inside them an energy of 27,740 MeV.

We saw that the three quarks in the nucleus have an energy of 20,244 MeV and we saw that the ability of this core when the universe was at an age of 5,40 microseconds. The photons in the universe 5,40 microseconds after the big bang, that is, when it formed the ordinary matter.

The difference of 7,496 MeV can be justified considering that it belongs to the three gluons that bind together to the three quarks.

Because the energy stored in the core photonic is only 27,740 MeV, it is deduced that the remaining 911,71 MeV of energy belongs to that part of the photon between the core and the shell.

This energy belongs to quarks, antiquarks and gluons.

The Photons in the Universe 5,40 Microseconds after the Big Bang, When It Formed the Ordinary Matter

Photon mass = 1,67454 x 10^{-24} g
Temperature = 2,189 x 10^{12} Kelvin
Photon frequency = 2,2715 x 10^{23} hertz
Photon wavelength = 1,320 x 10^{-13} cm
Photon radius = 1,320 x 10^{-13} cm
Photon energy = 1,505 x 10^{-3} erg = 1,505 x 10^{-10} Joule = 939 MeV
Photon density average = 1,739 x 10^{14} g/cm^3
core density = 7173 x 10^{14} g/cm^3
momentum = m c R = h = 6,626 x 10^{-27} erg x s
speed of light = 2,99792 x 10^{10} cm/s
elementary electric charge = 1,602 x 10^{-19} Coulomb
electric field = 4,588 x 10^{22} N/C
magnetic field = 1,530 x 10^{14} T
a = radius of the core = 2,544 x 10^{-17} m
b = wavelength = radius of the shell = 1,320 x 10^{-15} m
U = core energy = 4,444 x 10^{-12} Joule

quark mass up = 0.9 x 10^{-26} g
quark mass down = 1,8 x 10^{-26} g
total mass (2 quark up + 1 quark down) = 3,6 x 10^{-26} g
mass of the core = 4,944 x 10^{-26} g
photon voltage = 55,484 x 10^{6} Volt

Digression on Cosmology

The equations proposed were verified for photons with maximum frequency of 10^{121} hertz. A single photon with this frequency was existed at the big bang.

At the time of 2,570 x 10^{-117} s, the Universe was pervaded by photons which possessed, each, a mass of 0,736 x 10^{35} kg (36.000 time that of the Sun) and their frequency had a value of 1,000 x 10^{85} hertz. Each of these photons possessed a volume of 1,128 x 10^{-229} m^3 and had a temperature of 9,663 x 10^{73} kelvin.

This photon was infinitely small, but possessed a mass equivalent to that of about 10 billion of masses as that of the Earth and possessed a temperature of about 10^{74} kelvin. Photons of this species behaved like a microscopic black hole.

At the time of 1,376 x 10^{-57} s, the Universe was pervaded by photons which possessed, each, a mass of 1 kg and their frequency had a value of 1,358 x 10^{50} hertz. Each of these photons possessed a volume of 4,504 x 10^{-125} m^3 and had a temperature of 1,312 x 10^{39} kelvin.

My new model of the Universe (not yet published) informs us that the mass of the Universe, at the Big Bang, was of 1,534 x 10^{71} kg and also informs us that this event took place at a time of 9,303 x 10^{-195} second. At that time the Universe was constituted by a single particle, with a volume of 12,525 x 10^{-339} m^3 and a frequency of

2,080 x 10^{121} hertz, and it, while possessing an infinitely great mass, behaved like a particle and obeyed the equation proposed:

$$e = h \cdot v = \left\{1{,}584 \cdot 10^{-178} \cdot \frac{[8{,}155 \cdot 10^{-25} \cdot (2{,}080 \cdot 10^{121})^2]^2}{2{,}99792 \cdot 10^{8} \cdot 12{,}56 \cdot 10^{-7}} \cdot (2{,}080 \cdot 10^{121})^8\right\}^{1/3} \cdot 12{,}525 \cdot 10^{-339} \cdot 9 \cdot 10^{16} = 2 \cdot 10^{88}\ J$$

Were:

8,155 x 10^{-25} x (2,080 x 10^{121})^2 = (electric field) = 35,281 x 10^{217} N/C
35,281 x 10^{217}/2,99792 x 10^{8} = magnetic field = 11,760 x 10^{209} T
Module Poynting = 33,033 x 10^{433} W/m^2
Density material = 122,197 x 10^{407} kg/m^3
Volume of the Universe = 12,525 x 10^{-339} m^3
Mass of the universe = 12,525 x 10^{-339} x 122,197 x 10^{407} = 1,530 x 10^{71} kg

Wien's law informs us that a photon with this wavelength has a temperature of 2,005 x 10^{110} kelvin. If the photon that we are examining possesses a volume V = (4/3) $\pi \lambda^3$ and if this volume corresponds, for the law of Stefan-Boltzmann, to V= 1,380 x 10^{95} erg / (3,543 x 10^{-15} T^4), we can derive the temperature by the following equation:

$$\frac{4}{3}\pi \cdot \lambda^3 = \frac{1{,}380 \cdot 10^{95}\ erg}{3{,}543 \cdot 10^{-15} \cdot \frac{erg}{cm^3 \cdot K^4} \cdot T^4}$$

This temperature corresponds to the temperature that there is provided by the equation of Wien. Hast, we observe that the particle with a mass of 1,530 x 10^{71} kg is by far larger than that which is currently present in the Universe that we can observe.

My model of the Universe, which does not get published, shows that this mass has formed the current Universe and also shows that the equation I propose can justify the evolution of the Universe from the Big Bang at the present times.

Pressure of Photons

We know that a photon with frequency 1,350 x 10^{50} hertz possesses an energy of 9 x 10^{16} Joule (9 x 10^{23} erg) and we also know that it exhibits a pressure which is a function of the volume of the container in which it is contained, but not depends on the shape of the container.

A mental experiment will allow us to justify by means of Newtonian mechanics the pressure that a photon produces when it is in a container. This same experiment will allow us to verify the correctness of the properties that the proposal equation gives us. If, in fact, the photon that we are considering did not possess a very dense mass, such as that which the equation gives us, we would not have been able to use, in this case, Newtonian mechanics.

Now suppose o place the photon with frequency of 1,350 x 10^{50} hertz, in an imaginary container of 30 cm^3. Physics allows us to know that the pressure exerted by this photon would be 3 x 10^{22} dyne/cm^2 (30 million billion bar). This pressure is obtained by dividing the energy of the photon for the volume that contains it. The conditions that we are dealing with are extremely prohibitive, also by virtue of the fact that a photon with such characteristics has, to Wien's law, a temperature of 1,312 x 10^{39} kelvin. Physics does not give us any information on the dynamics of this particle because it does not admit that it can have a mass and an acceleration.

The equation proposed informs us that the photon in question has a mass of 1 kg that occupies a volume of 4,504 x 10^{-119} cm^3, and this allows us to assume that this photon can be placed in a container of 30 cm3 and can move within it.

Now consider a prismatic container 10 cm long and with a base of 3 cm^2 and assume that the photon moves horizontally along the entire length of the container before hitting against her wall. Physics considers that a material object moving at a constant speed cannot express an acceleration. The Kinetic Theory of ideal gases calculates the pressure of the particles that move at a constant speed using the change of direction of their momentum.

In my work, I have shown that light obeys the following equation that relates its wave with its particle. The equation $e = mc^2$ indicates that a photon of mass m can move at the speed of light and its kinetic energy is $e = mc^2$. It also indicates that the photon has an acceleration which depends on the time that it takes to travel a certain space after the collision against a wall.

This information comes to us if we rewrite the equation as follow:

$E = m (c/t) s$; were: $s = space = c \cdot t$

That a material particle, such as a photon or a Planck mass, can move at the speed of light was demonstrated by me in the paper [15].

Now, with the equation written above instead I demonstrate that a photon that a photon that moves at a constant speed may be subject to an acceleration. This is a new concept that has important implications and revolutionizes our knowledge.

The acceleration that we are given by the equation $e = mc^2$ clearly indicates that the strength of the photon depend on the length of the route. If the photon travels for a time very large, its strength decreases, and when it hits the wall, it does so with less momentum. This means that a photon produces more damage when it begins its run that after a shorter or longer time in which it moves. We saw earlier that the photon that we are considering produces a pressure of 30 million billion bar. This photon produces the same pressure even if we consider that it possesses an acceleration.

My model informs us that the photon that produces this astonishing pressure is a photon that has a mass of 1000 g contained in a volume of 4,504 x 10^{-119} cm^3. Wien's law informs us that his temperature is 1,312 x 10^{39} kelvin. The properties of this photon are so surprising that it is almost impossible to imagine that it may be enclosed in a container of 30 cm^3.

If this photon travels horizontally inside the container, it employs a time of 33,33 billionth of a second, and it's acceleration (c/t) is 8,994 x 10^{19} cm/s^2. The force with which this photon, with a mass of 1000 g, hits the wall is 8,994

x 10^{22} dynes and the pressure that it determines on the wall of 3 cm^2 is 2,998 x 10^{22} dyne/cm^2.

This pressure is the same as what is expected from the physics and this shows that my model works perfectly.

If we now suppose to put in a container, such as the one we discussed above, a photon with frequency 10^{85} Hz and with energy of 6,626 x 10^{58} erg, we obtain, according to physics, a pressure of 0,220 x 10^{58} dyne/cm^2. This photon, so special, has a mass of 0,736 x 10^{38} g which is 36.984 times greater than that of the Sun. This photon possesses a volume of 1,128 x 10^{-129} m^3 and is, therefore, infinitely dense and infinitely small. The acceleration of this photon it is 0,9 x 10^{20} cm/s^2 and the force with which it impacts the wall of 3 cm^2 is 0,662 x 10^{58} dyne. The pressure produced by the photon is of 0,220 x 10^{58} dyne/cm^2 and corresponds to that provided by physics.

Conclusions

The light has been considered for a long time as a property of energy that behaves ambivalent: according to this way of thinking, its behaviour can be to an energetic particle or that of an electromagnetic wave. For some time, the idea is emerging that light can manifest simultaneously this double nature. This my work has shown, making use of new equations of the Autor, that the light is composed of material particles which possess a structure such as that of the atoms.

In this work, I have shown also that each photon behaves as a capacitor spherical and that it obeys the equations of the capacitors. The behaviour similar to that of the capacitors requires that each photon must possess at its center a positive elementary electric charge from which develops an electric field and also entails that each photon, in order to achieve electrical neutrality, must possess an elementary electric charge negative.

This negative charge needs to be supported by a mass and must rotate at the speed of light and must describe a circular trajectory with a radius equal to that of the wavelength of the photon. The rotation of the negative charge causes a magnetic field that is directed towards the core of the photon. The presence of a magnetic field and an electric field within a spherical space well defined shows that the electromagnetic wave is developed within a photon.

This, in the light of my demonstrations, can not be considered, as has been done so far, as a corpuscle of pure energy but must be considered as a corpuscle material also characterized by a density directly proportional to its frequency.

This work also allows you to make predictions about how the Universe from the big bang to the present and is therefore a link between the quantum and classical physics.

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Pasquale Acquaro was born in Vibo Valentia (Italy). He gratuated in chemistry (physical chemistry) at the University of Padua (Italy) in 1972. He won the competition for the teaching of matematics. He was professor of chemistry in technical schools of Italy and took part in some competitions of the Ministero dei Beni Culturali e Ambientali of Italy and has received very positive reviews by academics of the Accademia dei Lincei as Nicola Cabibbo, Piero Caldirola, Luigi Radicati, Lamberto Malatesta etc...I was a member, for seventeen years, of the Società Chimica Italiana (SCI) and has presented numerous communications in national congresses of the SCI. He was invited to partecipate, with its oral communication entitled "Photons present a double nature: they are waves and material particles at the same time and follow a physical law", to a national conference convened by Italian National Agency for New Technologies Energy and the Environment of Rome (ENEA) and by Associazione Italiana Sensori e Microsistemi (AISEM). He is the author of a book on cosmology entitled "Un microscopico buco nero all'origine dell'universo" edizioni Monteleone, and he is the author of an equation of state for gases and liquids highly compressed, that magazine "La Chimica e L'Industria" of Milan (Italy) he judged this equation the best among those proposed so far and that the magazine Didattica delle Scienze of Brescia (Italy) has published under title very pretentious "Da van der Waals ad Acquaro". In January 2012, the AISEM has published a book containing a selection of the papers presented at the 16th conference on sensors and microsystems and between them he has entered the author's work entitled "An investigation on the double nature of photons". In this work there is also an equation of the author that demonstrates that photons have a mass directly proportional to their frequency. In the same work the author proposed, anticipating the conclusions arrived at by several international research groups, that the Principle of Complementarity of Bohr can be circumverted. Other fields of interest to the author are termodynamics and particle acceleration. He has critically reviewed the theory of Carnot on heat engines and the concept of internal energy and has revised critically the wavelength of de Broglie. Another field of interest for the author are the cosmology. He is currently preparing a book about the Universe in which it also shows how it originated the big bang and what are, in a new and original, the mechanisms that regulate the expansion of the universe for a time that precedes the Planck time and up to the present day and beyond. This model produces temperatures, volumes and energies in perfect agreement with those of cosmology. In June 2015 it was published by the international journal " Frontiers in Sensors" my article entitled "The Photons, Contrary to What is Believed, Have a Mass and Density and They Obey the Law of Stefan-Boltzmann". In this article of mine I say that photons, contrary to what is believed, have a mass that is justified by 32 constants of physics and I also said that photons possess a density proportional to their frequency. Furthermore, I stated the photons that possess these caracteristics obey the law of Stefan-Boltzmann.

Appendix 1

I have to prove that the electric field of photon can be calculated using the equation $E = 8{,}155 \times 10^{-25}$.

The following equation of my production:

$$h \cdot \nu = \left\{ \left[1{,}584 \cdot 10^{-178} \cdot \left(\frac{E \cdot B}{\mu_0} \right) \cdot \nu^8 \right]^{1/3} \cdot \left(\frac{4}{3} \pi \cdot \frac{c^3}{\nu^3} \right) \right\} \cdot c^2$$

were:

$\{[1{,}584 \times 10^{-178} (E\ B/\mu_0)\ \nu^8]^{1/3}\ [(4/3)\ \pi\ (c^3/\nu^3)]\}$ = mass of the photon (kg)
$\{[1{,}584 \times 10^{-178} (E\ B/\mu_0)\ \nu^8]^{1/3}$ = photon density (kg/m^3)
E = electric field (N/C)
B = magnetic field (T) = E/c
c = light speed = 2,99792 x 10^8 m/s
μ_0 = magnetic constant = 12,566 x 10^{-7} (NA^{-2})
ε_0 = electric constant = 8,85 x 10^{-12} (F m^{-1})

This shows that a photon has an energy that is a function of the electric field and the magnetic field and which corresponds perfectly to energy e = h .

Replacing in this equation the magnetic field B with the relationship between the electric field and the speed of light, you can obtain the following equation:

$$h \cdot \nu = \left\{ \left[1{,}584 \cdot 10^{-178} \cdot \left(\frac{E^2}{c \cdot \mu_0} \right) \cdot \nu^8 \right]^{1/3} \cdot \left(\frac{4}{3} \pi \cdot \frac{c^3}{\nu^3} \right) \right\} \cdot c^2$$

$$h \cdot \nu = \left\{ \left(1{,}584^{1/3} \cdot 10^{-178/3} \cdot \frac{E^{2/3}}{c^{1/3} \cdot \mu_0^{1/3}} \cdot \nu^{8/3} \right) \cdot \left(\frac{4}{3} \pi \cdot \frac{c^3}{\nu^3} \right) \right\} \cdot c^2$$

$$h \cdot \nu = \left\{ \left(1{,}584^{1/3} \cdot 10^{-178/3} \cdot \frac{E^{2/3}}{c^{1/3} \cdot \mu_0^{1/3}} \cdot \nu^{8/3} \right) \cdot \left(\frac{4}{3} \pi \cdot \frac{c^{9/3}}{\nu^{9/3}} \right) \right\} \cdot c^{6/3}$$

$$h \cdot \nu = 1{,}584^{1/3} \cdot 10^{-178/3} \cdot \frac{E^{2/3}}{\mu_0^{1/3}} \cdot \frac{c^{14/3}}{\nu^{1/3}} \cdot \frac{4}{3} \pi$$

$$E^{2/3} = \frac{h \cdot \nu^{3/3} \cdot \nu^{1/3} \cdot \mu_0^{1/3} \cdot 3}{1{,}584^{1/3} \cdot 10^{-178/3} \cdot c^{14/3} \cdot 4\pi}$$

$$E = \frac{h^{3/2} \cdot \nu^{(4/3)\cdot(3/2)} \cdot \mu_0^{(1/3)\cdot(3/2)} \cdot 3^{3/2}}{1{,}584^{(1/3)\cdot(3/2)} \cdot 10^{(-178/3)\cdot(3/2)} \cdot c^{(14/3)\cdot(3/2)} \cdot 4^{3/2} \cdot \pi^{3/2}}$$

$$E = \frac{h^{3/2} \cdot \nu^2 \cdot \mu_0^{1/2} \cdot 3^{3/2}}{1{,}584^{1/2} \cdot 10^{-178/2} \cdot c^7 \cdot 4^{3/2} \cdot \pi^{3/2}}$$

$$E = \left(\frac{(6{,}626 \cdot 10^{-34})^{3/2} \cdot (12{,}566 \cdot 10^{-7})^{1/2} \cdot 5{,}1961}{1{,}258 \cdot 10^{-178/2} \cdot (2{,}99792 \cdot 10^8)^7 \cdot 8 \cdot 5{,}564} \right) \cdot \nu^2$$

$$E = \left(\frac{1{,}7055 \cdot 10^{-50} \cdot 1{,}1209 \cdot 10^{-3} \cdot 5{,}1961}{1{,}258 \cdot 10^{-89} \cdot 2{,}176 \cdot 10^{59} \cdot 8 \cdot 5{,}564} \right) \cdot \nu^2 = \frac{9{,}934 \cdot 10^{-53}}{1{,}218 \cdot 10^{-28}} \cdot \nu^2 = 8{,}155 \cdot 10^{-25} \cdot \nu^2$$

Appendix 2

I have to prove that the radius of the nucleus of photon can be calculated using the equation: a = 0,01928 λ.

$$E = 8{,}155 \cdot 10^{-25} \cdot \nu^2 = 8{,}155 \cdot 10^{-25} \cdot \frac{c^2}{\lambda^2} = \text{electric field of photon} \qquad [A]$$

$$E = \frac{Q}{4\pi \cdot \varepsilon_0} \cdot \frac{b - a}{a \cdot b^2} = \text{electric field of photon}$$

poichè $\lambda = b$ risulta:

$$E = \frac{Q}{4\pi \cdot \varepsilon_0} \cdot \frac{\lambda - a}{a \cdot \lambda^2} = \frac{\text{voltage}}{\lambda} = \text{electric field of photon} \quad [B]$$

From the comparison between [A] e [B] is obtained:

$$8{,}155 \cdot 10^{-25} \cdot \frac{c^2}{\lambda^2} = \frac{Q}{4\pi \cdot \varepsilon_0} \cdot \frac{\lambda - a}{a \cdot \lambda^2}$$

$$8{,}155 \cdot 10^{-25} \cdot (2{,}99792 \cdot 10^8)^2 = \frac{1{,}602 \cdot 10^{-19}}{4 \cdot 3{,}14 \cdot 8{,}85 \cdot 10^{-12}} \cdot \frac{\lambda - a}{a}$$

$$7{,}329 \cdot 10^{-8} = 1{,}441 \cdot 10^{-9} \cdot \frac{\lambda - a}{a}$$

$$7{,}329 \cdot 10^{-8} \cdot a = 1{,}441 \cdot 10^{-9} \cdot \lambda - 1{,}441 \cdot 10^{-9} \cdot a$$

$$7{,}329 \cdot 10^{-8} \cdot a + 1{,}441 \cdot 10^{-9} \cdot a = 1{,}441 \cdot 10^{-9} \cdot \lambda$$

$$7{,}473 \cdot 10^{-8} \cdot a = 1{,}441 \cdot 10^{-9} \cdot \lambda$$

$$a = \frac{1{,}441 \cdot 10^{-9}}{7{,}473 \cdot 10^{-8}} \cdot \lambda = 0{,}01928 \cdot \lambda$$

from here you get:

a = radius of the core photonic = 0,01928 λ

Appendix 3

I have to show that k_A which is present in the following equation has a value of $1{,}584 \times 10^{-178}$.

$$e = h \cdot \nu = \left\{ \left[k_A \cdot \left(\frac{E \cdot B}{\mu_0} \right) \cdot \nu^8 \right]^{1/3} \cdot V_{phot} \right\} \cdot c^2 = m \cdot c^2$$

The Maxwell theory informs us that the total energy density instantaneous is generated by energy density associated with the electric field and with the magnetic field [4].

$$u = \varepsilon_0 \cdot E^2;$$

E = electric field intensity

If a photon is enclosed in a volume, it must obey the equations:

$$\frac{h \cdot \nu}{V_{phot}} = \varepsilon_0 \cdot E^2$$

$$\frac{h \cdot \nu}{\frac{4}{3}\pi \cdot \lambda^3} = \varepsilon_0 \cdot E^2 \quad [A]$$

If that photon has a mass and if it has a radius equal to its wavelength, and if it rotates on itself at the speed of light, it obeys at the equation:

$$m_{phot} \cdot c \cdot \lambda = h$$

from here you get:

$$\lambda = \frac{h}{m_{phot} \cdot c} \quad [B]$$

The equations [B] and [A] provide:

$$\frac{h \cdot \nu}{\frac{4}{3}\pi \cdot \left(\frac{h}{m_{phot} \cdot c} \right)^3} = \varepsilon_0 \cdot E^2$$

from here you get:

$$m_{phot} = \left(\frac{4\pi \cdot h^2 \cdot \varepsilon_0 \cdot E^2}{3 \cdot c^3 \cdot \nu}\right)^{1/3} \quad [C]$$

I replace the electric field E with the product of magnetic field for the speed of light:

$$m_{phot} = \left(\frac{4\pi \cdot h^2 \cdot \varepsilon_0 \cdot E \cdot B \cdot c}{3 \cdot c^3 \cdot \nu}\right)^{1/3}$$

I replace the speed of light in the numerator with: $\frac{1}{\mu_0^{1/2} \cdot \varepsilon_0^{1/2}}$

$$m_{phot} = \left(\frac{4\pi \cdot h^2 \cdot \varepsilon_0 \cdot E \cdot B}{3 \cdot c^3 \cdot \nu \cdot \mu_0^{1/2} \cdot \varepsilon_0^{1/2}}\right)^{1/3}$$

I replace the speed of light in denominator with: $\frac{G^{1/3} \cdot h^{1/3}}{l_p^{2/3}}$

$$m_{phot} = \left(\frac{4\pi \cdot h^2 \cdot \varepsilon_0 \cdot E \cdot B \cdot l_p^{2/3}}{3 \cdot c^2 \cdot \nu \cdot G^{1/3} \cdot h^{1/3} \cdot \mu_0^{1/2} \cdot \varepsilon_0^{1/2}}\right)^{1/3}$$

$$m_{phot} = \left(\frac{4\pi \cdot h^{5/3} \cdot \varepsilon_0^{1/2} \cdot E \cdot B \cdot l_p^{2/3}}{3 \cdot c^2 \cdot \nu \cdot G^{1/3} \cdot \mu_0^{1/2}}\right)^{1/3}$$

I multiply the numerator and denominator for $\mu_0^{1/2}$

$$m_{phot} = \left(\frac{4\pi \cdot h^{5/3} \cdot \varepsilon_0^{1/2} \cdot l_p^{2/3} \cdot \mu_0^{1/2} \cdot E \cdot B}{3 \cdot c^2 \cdot \nu \cdot G^{1/3} \cdot \mu_0}\right)^{1/3}$$

Dividing among themselves the equation written above with the following equation:

$$Vol\ phot = \frac{4}{3}\pi \cdot \lambda^3 = \frac{4}{3}\pi \cdot \frac{c^3}{\nu^3}$$

we get

$$density\ of\ the\ photon = \left(\frac{108 \cdot h^{5/3} \cdot \varepsilon_0^{1/2} \cdot l_p^{2/3} \cdot \mu_0^{1/2}}{192 \cdot c^{11} \cdot G^{1/3} \cdot \pi^2} \cdot \frac{E \cdot B}{\mu_0} \cdot \nu^8\right)^{1/3} =$$

$$= \left[\frac{(6{,}626 \cdot 10^{-34})^{5/3} \cdot (8{,}85 \cdot 10^{-12})^{1/2} \cdot (4{,}050 \cdot 10^{-35})^{2/3} \cdot (12{,}566 \cdot 10^{-7})^{1/2} \cdot 0{,}5625}{(2{,}99792 \cdot 10^{8})^{11} \cdot (6{,}673 \cdot 10^{-11})^{1/3} \cdot 3{,}14^2} \cdot \frac{E \cdot B}{\mu_0}\right]^{1/3} =$$

$$= \left(\frac{23{,}375 \cdot 10^{-56{,}666} \cdot 2{,}974 \cdot 10^{-6} \cdot 2{,}540 \cdot 10^{-23{,}333} \cdot 3{,}544 \cdot 10^{-3{,}5} \cdot 0{,}5625}{175800{,}632 \cdot 10^{88} \cdot 1{,}882 \cdot 10^{-3{,}666} \cdot 9.859} \cdot \frac{E \cdot B}{\mu_0}\right)^{1/3} =$$

$$= \left(\frac{351{,}999 \cdot 10^{-89{,}499}}{3261917{,}087 \cdot 10^{84{,}334}} \cdot \frac{E \cdot B}{\mu_0}\right)^{1/3} =$$

$$= \left(\frac{1{,}115 \cdot 10^{-87}}{7{,}038 \cdot 10^{90}} \cdot \frac{E \cdot B}{\mu_0}\right)^{1/3} = \left(1{,}584 \cdot 10^{-178} \cdot \frac{E \cdot B}{\mu_0}\right)^{1/3}$$

Appendix 4

I have to prove that the energy that photon vacuum capacitor is able to accumulate is deposited entirely in the nucleus. This energy is 33,84 times smaller than that possessed by the photons.

$$U = 0{,}5 \cdot Q \cdot V = 0{,}5 \cdot Q \cdot \left(\frac{Q}{4\pi \cdot \varepsilon_0} \cdot \frac{b-a}{a \cdot b}\right) =$$

$$= \frac{0{,}5 \cdot Q^2}{4\pi \cdot \varepsilon_0} \cdot \left(\frac{\lambda - 0{,}01928 \cdot \lambda}{0{,}01928 \cdot \lambda^2}\right) =$$

$$= \frac{0{,}5 \cdot (1{,}602 \cdot 10^{-19})^2}{12{,}56 \cdot 8{,}85 \cdot 10^{-12} \cdot 0{,}01928} \cdot \frac{\lambda - 0{,}01928 \cdot \lambda}{\lambda^2} =$$

$$= \frac{5{,}987 \cdot 10^{-27}}{\lambda^2} \cdot (1 - 0{,}01928) \cdot \lambda =$$

$$= 5{,}871 \cdot 10^{-27}\,\lambda = 5{,}871 \cdot 10^{-27} \cdot \frac{\nu}{c} = 1{,}958 \cdot 10^{-35} \cdot \nu = \frac{h\,\nu}{33{,}840}$$

Appendix 5

I have to prove that the mass carrying the negative electric charge possesses an energy 16,92 times smaller than that of the photon.

In chapter "Negative electric charge", we found that an electrical charge need, for move about, of a support material.

If an electric charge moves on a circular orbit, placed on a plane perpendicular to that on which is placed the magnetic field, it must verify the equation [4]:

$$R = \frac{m \cdot c}{Q \cdot B}$$

R = photon radius (m)
m = mass which support negative electrical charge (kg)
Q = elementary electrical charge = 1,602 x 10^{-19} Coulomb
B = magnetic field (T)
c = speed of light = 2,99792 x 10^{8} m/s

$$R = \frac{m \cdot c}{Q \cdot B} = \lambda$$

$$\text{as:} \quad B = \frac{E}{c}, \quad \text{result:} \quad \lambda = \frac{m \cdot c^2}{Q \cdot E},$$

$$\text{and as:} \quad \lambda = \frac{c}{\nu}, \quad \text{result:} \quad \frac{c}{\nu} = \frac{m \cdot c^2}{Q \cdot E}$$

From this last equation is obtained:

$$m \cdot c^2 = Q \cdot E \cdot \frac{c}{\nu}, \qquad \text{were:} \quad E = 8{,}155 \cdot \nu^2 \cdot 10^{-25}$$

From this equation is obtained:

$$m \cdot c^2 = Q \cdot (8{,}155 \cdot \nu^2 \cdot 10^{-25})\,\frac{c}{\nu} = Q \cdot 8{,}155 \cdot 10^{-25} \cdot \nu \cdot c$$

$$m \cdot c^2 = (1{,}602 \cdot 10^{-19} \cdot 8{,}155 \cdot 10^{-25} \cdot 2{,}99792 \cdot 10^{8}) \cdot \nu\,;$$

$e = m\,c^2$ = energy, positioned on the mass m, carrying the elementary electrical charge negative:

$$e = m \cdot c^2 = 3{,}916 \cdot 10^{-35} \cdot \nu;$$

$$e = 3{,}916 \cdot 10^{-35} \cdot \nu = \frac{h}{\frac{33{,}840}{2}} \cdot \nu = \frac{6{,}626 \cdot 10^{-34}}{\frac{33{,}840}{2}} \cdot \nu = \frac{6{,}626 \cdot 10^{-34}}{16{,}92} \cdot \nu$$

Table

The energies that are given in the table below show the goodness of the equation proposed:

$$e = h \cdot \nu = \left\{ \left[k_A \cdot \left(\frac{E \cdot B}{\mu_0} \right) \cdot \nu^8 \right]^{1/3} \cdot V_{phot} \right\} \cdot c^2 = m \cdot c^2$$

	Frequency (Hz)					
	$2{,}271 \times 10^{23}$	$5{,}000 \times 10^{18}$	$1{,}000 \times 10^{85}$	$2{,}820 \times 10^{11}$	1,000	$1{,}000 \times 10^{38}$
Wavelength (m)	$1{,}320 \times 10^{-15}$	$5{,}996 \times 10^{-11}$	$2{,}998 \times 10^{-77}$	$1{,}063 \times 10^{-3}$	$2{,}998 \times 10^{+8}$	$2{,}998 \times 10^{-30}$
Temperature (K)	$2{,}195 \times 10^{12}$	$4{,}832 \times 10^{7}$	$9{,}663 \times 10^{73}$	2,725	$9{,}663 \times 10^{-12}$	$9{,}666 \times 10^{26}$
Electric field (N/C)	$4{,}558 \times 10^{22}$	$2{,}224 \times 10^{13}$	$8{,}145 \times 10^{145}$	$7{,}074 \times 10^{-2}$	$8{,}895 \times 10^{-25}$	$8{,}895 \times 10^{51}$
Magnetic field (T)	$1{,}530 \times 10^{14}$	$7{,}418 \times 10^{4}$	$2{,}717 \times 10^{137}$	$2{,}360 \times 10^{-10}$	$2{,}967 \times 10^{-33}$	$2{,}967 \times 10^{43}$
Poynting module (W/m^2)	$5{,}587 \times 10^{42}$	$1{,}313 \times 10^{24}$	$1{,}761 \times 10^{289}$	$1{,}328 \times 10^{-5}$	$2{,}100 \times 10^{-51}$	$2{,}10 \times 10^{101}$
Volume (m^3)	$9{,}630 \times 10^{-45}$	$9{,}023 \times 10^{-31}$	$1{,}128 \times 10^{-229}$	$5{,}030 \times 10^{-9}$	$1{,}128 \times 10^{26}$	$1{,}128 \times 10^{-88}$
Photon density (kg/m^3)	$1{,}739 \times 10^{17}$	$4{,}086 \times 10^{-2}$	$0{,}652 \times 10^{264}$	$4{,}134 \times 10^{-31}$	$6{,}537 \times 10^{-77}$	$6{,}537 \times 10^{75}$
Mass of the photon (kg)	$1{,}674 \times 10^{-27}$	$3{,}687 \times 10^{-32}$	$0{,}736 \times 10^{35}$	$2{,}079 \times 10^{-39}$	$7{,}373 \times 10^{-51}$	$7{,}373 \times 10^{-13}$
Energy = hν (Joule)	$1{,}505 \times 10^{-10}$	$3{,}313 \times 10^{-15}$	$6{,}626 \times 10^{51}$	$1{,}869 \times 10^{-22}$	$6{,}626 \times 10^{-34}$	$6{,}626 \times 10^{4}$
Energy Author (Joule)	$1{,}505 \times 10^{-10}$	$3{,}313 \times 10^{-15}$	$6{,}626 \times 10^{51}$	$1{,}869 \times 10^{-22}$	$6{,}626 \times 10^{-34}$	$6{,}626 \times 10^{4}$
Radius of the core (m)	$2{,}545 \times 10^{-17}$	$1{,}156 \times 10^{-12}$	$5{,}780 \times 10^{-79}$	$2{,}050 \times 10^{-5}$	$5{,}78 \times 10^{6}$	$5{,}78 \times 10^{-32}$
Volume of the core (m^3)	$6{,}901 \times 10^{-50}$	$6{,}467 \times 10^{-36}$	$8{,}083 \times 10^{-235}$	$3{,}605 \times 10^{-14}$	$8{,}083 \times 10^{20}$	$8{,}083 \times 10^{-94}$
Mass of the core (kg)	$4{,}943 \times 10^{-29}$	$1{,}088 \times 10^{-33}$	$2{,}173 \times 10^{33}$	$6{,}137 \times 10^{-41}$	$2{,}176 \times 10^{-52}$	$2{,}176 \times 10^{-14}$
	Frequency (Hz)					
	$2{,}271 \times 10^{23}$	$5{,}000 \times 10^{18}$	$1{,}000 \times 10^{85}$	$2{,}820 \times 10^{11}$	1,000	$1{,}000 \times 10^{38}$
Energy of the core (Joule)	$4{,}444 \times 10^{-12}$	$9{,}784 \times 10^{-17}$	$1{,}957 \times 10^{50}$	$5{,}518 \times 10^{-24}$	$1{,}957 \times 10^{-35}$	$1{,}967 \times 10^{3}$
Mass of the charge (kg)	$9{,}885 \times 10^{-29}$	$2{,}176 \times 10^{-33}$	$4{,}346 \times 10^{33}$	$1{,}227 \times 10^{-40}$	$4{,}353 \times 10^{-52}$	$4{,}353 \times 10^{-14}$
Voltage (volt)	$5{,}553 \times 10^{7}$	$1{,}223 \times 10^{3}$	$2{,}445 \times 10^{69}$	$6{,}895 \times 10^{-5}$	$2{,}445 \times 10^{-16}$	$2{,}445 \times 10^{22}$
Angular mom. (Joule x s)	$6{,}626 \times 10^{-34}$	$6{,}626 \times 10^{-34}$	$6{,}626 \times 10^{-34}$	$6{,}626 \times 10^{-34}$	$6{,}626 \times 10^{-34}$	$6{,}626 \times 10^{-34}$